APPLICATION FOR UNITED STATES PATENT

in the name of

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of

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For

SPILL-RESISTANT RELIEF VALVE

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SPILL-RESISTANT RELIEF VALVE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a utility filing of the provisional application U.S. Patent Application Serial No. 60/419,417 filed on October 18, 2002, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

This invention relates to relief valves for fluid backflow preventers.

BACKGROUND OF THE INVENTION

Backflow preventers are used, e.g., in water distribution lines to restrict reverse flow of possibly contaminated water back towards a potable water supply.

Conventionally, a backflow preventer has one or a pair of unidirectional check valves and, downstream of the first check valve, a relief valve. The check valves open to permit flow through the line in the normal direction only, and close to restrict backflow through the line, should the direction of flow reverse. The relief valve, closed when flow is normal, opens during a backflow condition to drain the possibly contaminated water from the line downstream of the first check valve (typically between the pair of check valves). This drainage through the relief valve is particularly important when a check valve malfunctions, for example, by failing to close completely because fouled by debris, because it helps to restrict water from flowing past the partially open check valve.

SUMMARY OF THE INVENTION

It is recognized that, inherent with the design of reduced pressure backflow preventers, the relief valve will open and close in response to fluctuations in water supply pressure, without backflow. The resulting spillage and "spitting" are often perceived as a nuisance.

According to one aspect of the present invention, a small, spring-loaded pressurized chamber is placed in the high pressure sensing line attached to the relief valve. By providing a small, restricted orifice in the relief valve sensing line upstream of the chamber, when there is a drop in the supply pressure, the chamber, with its stored pressure, can temporarily supply the relief valve with the lost pressure, thereby to delay opening of the relief valve for a short period of time.

According to another aspect of the invention, a chamber containing a piston operated device is installed in a by-pass line around the first check valve of the reduced pressure backflow preventer. The piston operated device is spring loaded to approximately the same level as the first check valve, and when there is a drop in supply pressure, the piston shifts in its chamber to effectively increase the volume of the intermediate zone of the reduced pressure backflow preventer (at the service side of the first check valve, between the first and second check valves). Since water is non-compressible, an increase in the effective volume of the intermediate zone (responsive to the reduction in supply pressure) also reduces the pressure in the intermediate zone, thus maintaining sufficient differential pressure across the first check valve to temporarily delay opening of the relief valve.

In both instances, if the loss of pressure is simply the result of a brief fluctuation in water supply pressure, the pressure returns to normal and the relief valve remains closed with no spillage or spitting. The invention thus greatly enhances the ability of the reduced pressure backflow preventer equipped with a device of the invention to resist spitting and spillage due to fluctuations or sudden drops in the supply pressure when the backflow preventer is in static condition. If, on the other hand, a backflow condition develops, the relief valve opens after the short delay to relief pressure at the service side of the check valve.

In another aspect, a reduced pressure backflow preventer includes a body defining a passageway for flow of fluid between a supply pipe and a service pipe, a means for regulating flow in the passageway, a means for relieving pressure in the passageway, and a means for delaying flow from operation of the means for relieving pressure.

In another aspect, a reduced pressure backflow preventer includes a body defining a passageway for flow of fluid between a supply pipe and a service pipe. A first check valve assembly can be positioned in the passageway, while a relief valve assembly can be positioned downstream of the first check valve assembly. A reservoir can be coupled to the body and configured to release fluid in a manner to delay flow from operation of the relief valve assembly. The body can have a first conduit in fluid communication with the passageway downstream of the check valve and a second conduit in fluid communication with the passageway downstream of the check valve. The reduced pressure backflow preventer can include a first valve positioned in the first conduit; and the relief valve assembly can include a first diaphragm positioned in the

first conduit and a second valve positioned in the second conduit, where the first diaphragm is configured to actuate the first valve and the second valve.

The reduced pressure backflow preventer can also have the first diaphragm disposed in sealing engagement with an inside wall of the body to define a chamber, and the reduced pressure backflow preventer can include a tube providing fluid communication between the passageway upstream of the check valve and the chamber.

The reservoir can include a wall member disposed within the reservoir and defining a first reservoir portion fluidly isolated from a second reservoir portion. The wall member can be a flexible diaphragm. The reservoir can include a spring in biasing contact with the wall member. The wall member can alternatively be a first wall member and a second wall member, the first wall member and the second wall member being attached by a rod. The reservoir can also include a first port in fluid communication between the first reservoir portion and the passageway upstream of the check valve and a second port in fluid communication between the second reservoir portion and the passageway downstream of the check valve.

In another raspect a relief valve assembly includes a body defining a first conduit, a first valve positioned in the first conduit, a first diaphragm in sealing engagement with an inside wall of the body to define a chamber fluidly isolated from the first conduit, the first diaphragm being configured to actuate the first valve, and a reservoir in fluid communication with the chamber. The body can include a second conduit, and the relief valve assembly can includes a second valve in the second conduit with the first diaphragm being configured to actuate the second valve. The relief valve assembly can also include a connecting rod coupling the first valve and the second valve. The reservoir can include a wall member disposed within the reservoir and defining a first reservoir portion fluidly isolated from a second reservoir portion. The reservoir can include a first port in fluid communication between the first reservoir portion and the chamber. A spring can be in biasing contact with the wall member. The wall member can be a flexible diaphragm. Alternatively, the wall member can include a first wall member and a second wall member, the first wall member and the second wall member being interconnected in an H-shape cross-sectional configuration.

A method of stabilizing the operation of a relief valve in a backflow prevention assembly includes storing a fluid in a reservoir in fluid communication with the relief valve assembly, and, upon a loss of pressure in a supply pipe, releasing stored fluid into a first conduit of the relief

valve assembly. The method can include sensing loss of fluid pressure in the supply pipe, fo example, by sensing a pressure change at a diaphragm.

In another aspect, a reduced pressure backflow preventer can include a body defining a flow passageway in communication between a supply pipe and a service pipe, a first check valve and a second check valve disposed in the flow passageway and defining a flow chamber therebetween. The relief valve assembly can be disposed in communication with the flow chamber, with the relief valve assembly being responsive to pressure differential across the first check valve in a backflow situation to open to allow fluid to drain from the flow chamber outside of the body.

The relief valve assembly can include a diaphragm having a first surface exposed to a region in communication with the flow chamber at a service side of the first check valve and an opposite second surface exposed to a region in communication with the flow chamber at a supply side of the first check valve, where the diaphragm is responsive to a pressure differential between the first surface and the second surface to move between a first position, during normal flow, resisting flow of fluid through the relief valve assembly and a second position, during backflow, allowing flow fluid through the relief valve assembly. The relief valve assembly can include a stabilizer device that includes a fluid reservoir in communication with a volume at the second surface of the diaphragm and a flow constrictor orifice for resisting flow of fluid from the volume at the second surface of the diaphragm, for temporarily maintaining pressure at the second surface, thereby to temporarily delay movement of the diaphragm toward the second position during backflow.

In another aspect a reduced pressure backflow preventer includes a body defining a flow passageway in communication between a supply pipe and a service pipe, a first check valve and a second check valve disposed in the flow passageway, defining a flow chamber therebetween. The preventer includes a relief valve assembly disposed in communication with the flow chamber, the relief valve assembly being responsive to pressure differential across the first check valve in a backflow situation to open to allow fluid to drain from the flow chamber to outside of the body.

The relief valve assembly includes a diaphragm having a first surface exposed to a region in communication with the flow chamber at a service side of the first check valve and an opposite second side exposed to a region in communication with the flow chamber at a supply

side of the first check valve, the diaphragm being responsive to a pressure differential between the first surface and the second surface to move between a first position, during normal flow, resisting flow of fluid through the relief valve and a second position, during backflow, allowing flow fluid through the relief valve. The relief vlve assembly includes a relief valve charging device in communication between a first region at a supply side of the first check valve and a second region at a service side of the first check valve, where the charging device includes a chamber containing an element moveable in response to pressure differential across the first check valve and a spring biasing the element in a first direction, for increasing the effective volume of the second region in response to reduced pressure in the first region.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DRAWING DESCRIPTION

FIG. 1 is a partial view of a reduced pressure backflow preventer connected between a supply line and a service line.

FIG. 2 is a side section view of the reduced pressure backflow preventer of FIG. 1, taken along the line 2-2 of FIG. 1, with a stabilization device according to one aspect of the invention;

FIG. 3 is a somewhat diagrammatic view of an adapter defining a constricted orifice for use in the reduced pressure backflow preventer with the stabilization device of FIG. 2; and

FIGS. 4A, 4B and 4C are side sections views of embodiments of stabilization device of the invention.

FIG. 5 is a side section view of a reduced pressure backflow preventer of FIG. 1, taken along 2-2 of FIG. 1, with a stabilization device according to another aspect of the invention; and

FIGS. 6A, 6B and 6C are side section views of other embodiments the stabilization device of the invention.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2, a reduced pressure backflow preventer 12, having a body 13 connected between a supply pipe 14 and a service pipe 16, includes a check valve 18, a relief valve assembly 20, and a pressurized stabilization chamber 21 containing a fluid reservoir 22.

During normal operation, fluid, e.g. potable water, flows from the supply pipe 14, through the body 13, to the service pipe 16, as indicated by arrows, W. When a backflow condition occurs, fluid is urged to flow in a direction opposite to arrows, W. This results in a reduction in pressure in the region, X, at the supply side of the check valve 18, with a simultaneous increase in pressure in the region, Y, at the service side of the check valve 18, which actuates the pressurized stabilization chamber 21 to release water from the reservoir 22, thereby to delay opening of the relief valve assembly 20, as described in more detail below.

Referring to FIG. 2, the check valve 18 has a valve disk 30 mounted upon a stem 32. The stem in turn is mounted to slide in guide 34 and retainer 36, while spring 40 biases the valve disk into sealing contact upon opposed valve seat 41.

Relief valve assembly 20 communicates with the body passageway 45 at the service side of check valve 18 through upper passageway 42 and lower passageway 44. Passageways 42 and 44 respectively communicate through valves 46 and 48 to ports 50 and 52, open to the atmosphere. Lower passageway 44 communicates with body passageway 45 through port 47, below horizontal plane A, which includes the lowermost point of check valve seat 41. Upper passageway 42 communicates with body passageway 45 through port 49, above port 47.

Valve 48 has a piston 60 with an enlarged, circumferential shoulder 62 having four downwardly extending fingers 64. O-ring 68 in groove 66 seals between piston 60 and surrounding stainless steel sleeve 69 when the valve is closed. When the valve is open, the o-ring 68 is spaced from sealing contact.

Spring assembly 70 biases piston 60 upwardly. Coil spring 71 surrounds stem 72, while guide 74 is secured to the lower end of stem 72 and defines a shoulder 76 to receive one end of spring 71. The guide is threaded into plug 78, which in turn is threaded into valve body 79. The upper end of stem 72 extends into counterbore 80 of piston 60, and carries a nut 82. Button 84, free to slide along stem 72, fits in counterbore 86 within fingers 64, and receives the upper end of spring 71 on shoulder 88.

At the upper end of piston 60, gasket 90 in groove 92 of shoulder 94 seals against cylindrical wall 96 in valve body 79. Wall 96 is dimensioned to ensure that gasket 90 remains in sealing contact throughout the travel of piston 60, maintaining passageway 42 and port 50 continuously out of communication with passageway 44 and port 52.

Stem 98, connecting valves 46, 48, is pinned at one end in counterbore 100 in the upper end of piston 60, and at its other end in counterbore 102 in the bottom of guide 104 of valve 46. The upper portion of guide 104 has four fins 106 arranged at right angles and mounted to slide within stainless steel annular member 107, the sharp upper end of which defines valve seat 108. Valve disk 110 is mounted in recess 112 at the bottom of retainer 114, and rubber ring 116 is mounted in recess 118 near the outer periphery of disk 110, positioned for engagement with seat 108 between passageway 42 and port 50. At its upper end, guide 104 has an integral disk portion 120 and a threaded portion 122 screwed into hole 124, thereby clamping together retainer 114, disk 110, and ring 116.

Above valve 46, diaphragm 130 is clamped about its periphery between valve body 79 and cover 131, defining a chamber 132 between the cover 131 and the upper surface of the diaphragm 130. A petcock 140 mounted in cover 131 enables air to be bled from chamber 132. High pressure sensing line 142 provides communication between the passageway 45 in region, X, at the supply side of check valve 18 and chamber 132. Referring to FIG. 2 and 3, adapter 141 defines an orifice 152 having a flow circumference sized relative to the flow circumference of port 154 from reservoir 22 to control the rate of flow from the fluid reservoir 22. For example, port 154 has a diameter, P, e.g. about 0.250 inch to about 0.500 inch, while orifice 152 has a diameter, O, e.g. about 0.015 inch to about 0.100 inch.

In the embodiment shown, the stabilization chamber 21 is pressurized by a flexible diaphragm 144 in sealing engagement with the inner wall of the chamber, to define a first reservoir region 146 fluidly isolated from a second reservoir region 148 and from chamber 132. The port 154 fluidly connects the second reservoir region 148 with chamber 132.

Referring to FIGS. 4A, 4B and 4C, different embodiments of stabilization chambers for use according to the invention in the reduced pressure backflow preventer of FIG. 2 are shown. For example, in FIG. 4A, a stabilization chamber 22a consists of a container defining a single reservoir region 21a, to be filled with water. In FIG. 4B, the stabilization chamber 22 of FIG. 2 is shown in larger scale. In FIG. 4C, a pressurized stabilization chamber 22c contains a piston or rigid disk 144c defining a first reservoir region 146c and a second reservoir region 148c containing water. The piston 144c moves, in sealing engagement with the chamber wall, to pressurize air in the upper chamber.

OPERATION

Referring to FIG. 1-4, flow is normally from supply pipe 14, through open check valve 18 in reduced pressure backflow preventer 12, to service pipe 16. Relief valves 46 and 48 are closed. Due to flow resistance through the check valve, the pressure at the supply side of open check valve 18 (region, X), communicated by high pressure sensing line 142 to the chamber at the top side of diaphragm 130, is greater than the pressure at the service side of the check valve 18 (region, Y), communicated by passageway 42 to the underside of diaphragm 130. The differential pressure across diaphragm 130 urges the relief valves 46, 48 toward their closed positions, overcoming the upward biasing force of spring 71 acting against piston 60 of valve 48. The connected valves 46 and 48 are urged downwardly and respectively close against seat 108 and sleeve 69.

During a backflow condition, check valve 18 closes, and because the pressure in passageway 45 in the region, Y, at the service side of the check valve is now greater than the pressure in passageway 45 in the region, X, at the supply side of the check valve, the pressure differential across diaphragm 130 is reversed, and diaphragm 130 is urged toward a position to actuate and open relief valves 46, 48. However, the reversal of pressure differential across diaphragm 130 also causes fluid to flow from reservoir 22 into chamber 132, while flow of fluid from chamber 132 through high pressure sensing line 142 is restricted, i.e. slowed, by constricted orifice 152. As a result, opening of relief valves 46, 48 is temporarily delayed.

If the loss of pressure is simply the result of a brief fluctuation in supply pressure, the pressure differential returns to normal and the relief valves 46, 48 remain closed with no spillage or spitting. The ability of the reduced pressure backflow preventer equipped with a stabilization chamber device of the invention to resist spitting and spillage due to fluctuations or sudden drops in the supply pressure when the backflow preventer is in status condition is thereby improved.

If, on the other hand, a backflow condition develops, as flow from the stabilizing chamber 22 is exhausted, the pressure differential across the diaphragm 130 is reversed, urging it upwardly and reducing or removing the downward force acting against spring 71. The spring urges ring 116 of valve 46 from seat 108, breaking the seal between upper passageway 42 and port 50, to allow passageway 42 to vent to atmosphere. After valve 46 opens, O-ring 68 is withdrawn from sleeve 69, opening valve 48 to allow lower passageway 44 to vent to atmosphere through port 52. Water is discharged through valve 48 and, at least at first, valve 46.

When the water level in body passageway 45 drops below the entrance of upper passageway 42, air will be inspirated through upper passageway 42 above the draining water, which continues to discharge through lower passageway 44. The separate air intake passageway provides more rapid drainage than a single passageway relief valve system in which air intake and water discharge must take place concurrently through the same passageway. The relief valves 46, 48 are thus opened after the short delay to relieve pressure in region, Y, at the service side of the check valve 18.

Since the volume of the stabilizing chamber 22, the tension provided by the diaphragm 130, and the orifice sizes O, P, are known, the fluid flow rate can be precisely calibrated to provide pressure differential across the diaphragm for a specified time interval after a drop in supply pressure.

During a back siphonage condition, pressure in supply pipe 14 drops below atmospheric. Backflow from service pipe 16 closes check valve 18, and relief valves 46, 48 open as described above. Should debris foul the check valve 18 and prevent it from closing completely, suction in supply line 14 will draw backflow through the partially open check valve, despite drainage through the relief valve assembly. Advantageously, air intake through upper passageway 42 relieves the suction in supply pipe 14, increasing the rate of discharge through lower passageway 44, and reducing flow past the fouled check valve 18.

ALTERNATIVE EMBODIMENT

Referring now to FIGS. 5 and 6A, in an alternative embodiment of the reduced pressure backflow preventer described above with reference to FIGS. 1 and 2, a by-pass line 200 is installed around the first check valve 18, in communication between passageway 45 in the region, X, at the supply side of the check valve 18 and passageway 45 in the region, Y, at the service side of the check valve 18. A stabilization device 201, consisting of a chamber 202 containing a piston 204 biased by spring 206 toward the supply side region, X, is installed in the by-pass line. The piston 204, in sealing engagement with the inner wall of the chamber 202, serves to isolate the supply side pressure, in chamber portion 208, from the service side pressure, in chamber portion 209. The piston-operated stabilization device 201 is spring loaded to approximately the same level as the first check valve 18, and when there is a drop in supply pressure, the piston 204 shifts in its chamber (arrow, B) to effectively increase the volume of the

intermediate zone (region, Y) of the reduced pressure backflow preventer (at the service side of the first check valve 18, between the first and second check valves). Since water is non-compressible, an increase in the effective volume of the intermediate zone (responsive to the reduction in supply pressure) also reduces the pressure in the intermediate zone, thus maintaining sufficient differential across the first check valve 18 to temporarily delay opening of the relief valves 46, 48.

If the loss of pressure is simply the result of a brief fluctuation in water supply pressure, the pressure returns to normal and the relief valves remain closed with no spillage or spitting. The invention thus greatly enhances the ability of the reduced pressure backflow preventer equipped with a stabilization device of this embodiment of the invention to resist spitting and spillage due to fluctuations or sudden drops in the supply pressure when the backflow preventer is in status condition. If, on the other hand, a backflow condition develops, the relief valves open after the short delay to relief pressure at the service side of the check valve.

Referring to FIGS. 6B and 6C, in other embodiments of the stabilization device 210 and 220, respectively, the sealing piston 204 of FIG. 6A is replaced with a flexible diaphragm 212 (FIG. 6B) or a spool 222 (FIG. 6C).

OTHER EMBODIMENTS

Other embodiments are within the following claims, for example, two independently operable relief valves, one in the upper passageway, and one in the lower passageway, may be used in place of a connected valve arrangement. The lower valve may, by itself, open in response to a threshold pressure differential across the check valve. The upper valve may be arranged to open only in response to sub-atmospheric pressure downstream of the check valve, to allow air intake through the upper passageway.

A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the following claims.